

Hoh River watershed

The Hoh River watershed is the most southern located watershed within WRIA 20, as seen in Figure 3 below. The Queets River watershed of WRIA 21 is adjacent to the south, while the Elwah River watershed of WRIA 18 is located to the east. The large Quillayute River watershed of WRIA 20 is located to the north.

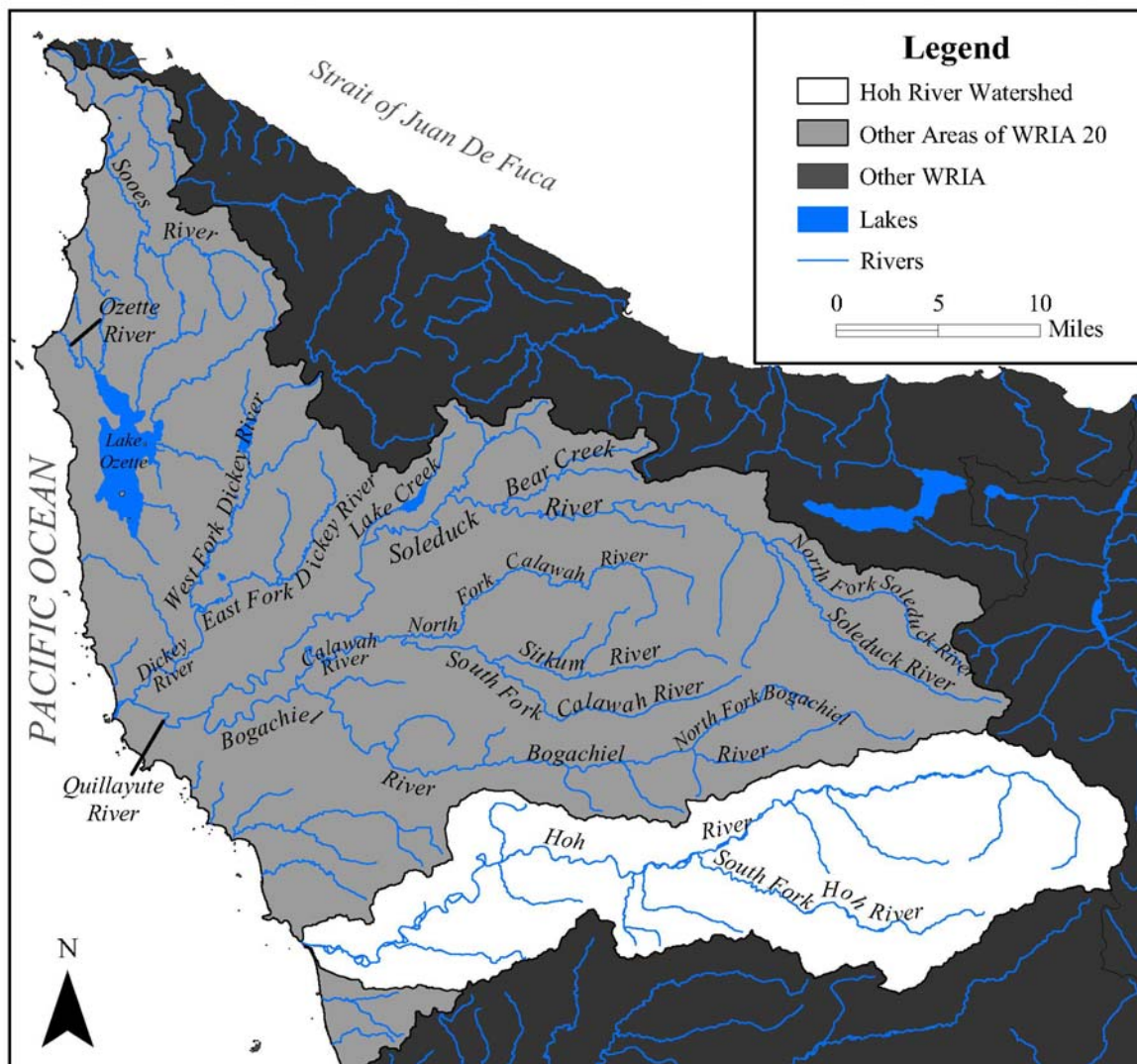


Figure 3. Location map of Hoh River watershed within WRIA 20.

Watershed Conditions and Seasonal Variability for Select Streams within WRIA 20

The Hoh River flows from east to west and outlets directly into the Pacific Ocean. Average annual precipitation varies significantly, with over 240 inches of precipitation along the ridge above Humes and Hoh Glaciers, down to 93 inches near the outlet. The entire watershed covers approximately 298 square-miles in area, and a large portion of the watershed is administered within the Olympic National Park and has therefore not been altered by timber harvesting practices. Figure 4 below illustrates the extent of the national park within the Hoh River watershed as well as the extent of other land administration categories.

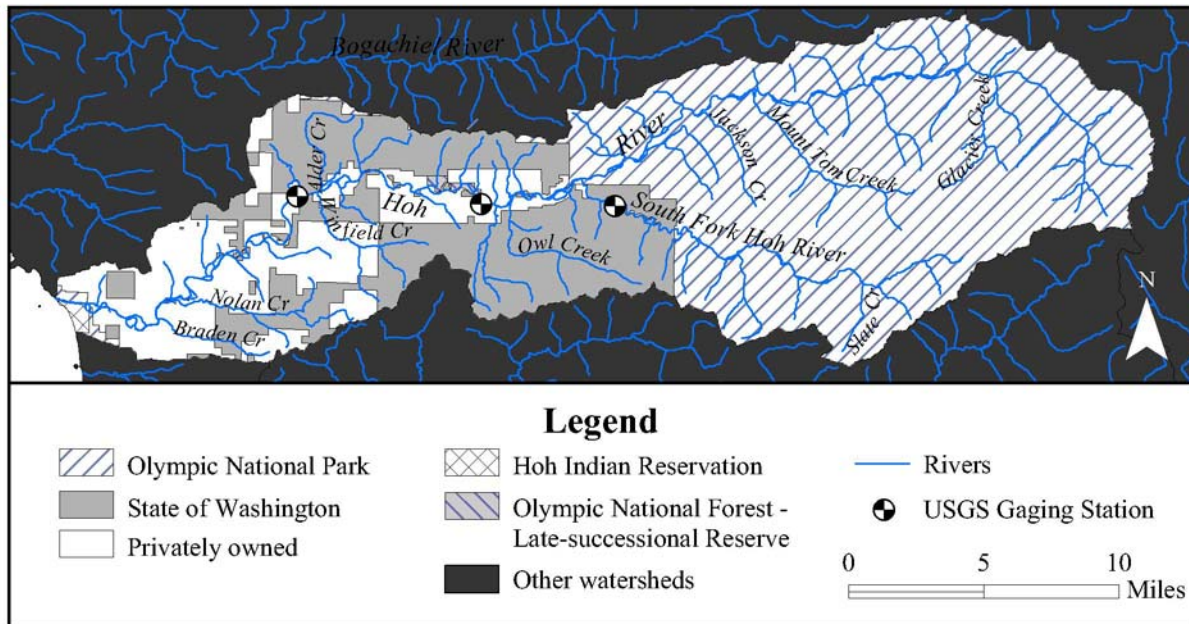


Figure 4. Land administration within the Hoh River watershed.

Table 1 below summarizes the areal extent of each administration category and the percent of the entire watershed that is administered by each category.

Table 1. Land administration areas within the Hoh River watershed.

Land Administration	Area* (sq. mi.)	Percent of Total Area*
Olympic National Park	171.7	57.6
Late-successional/Riparian Reserves (USFS)	0.64	0.22
State of Washington	72.6	24.4
Hoh Indian Reservation	0.63	0.21
Privately owned	52.5	17.6
Total Area	298.2	100

* = The sum of the areas will not equal the total due to rounding.

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Only a small portion of the remaining watershed may have been affected by implementation of the President's Northwest Forest Plan of 1994 by the USDA Forest Service. In this plan, Forest Service and some state and private in-holding lands outside of wilderness areas have been assigned specific management designations. The only wilderness areas within the Hoh River watershed are located within the Olympic National Park, which covers over half of the watershed. Only a small area of the watershed between River Mile (RM) 23 and 26 is managed by the Forest Service, all of which has been designated as Late-successional Reserve (LSR). This area measures approximately 0.64 square-miles and is "managed to protect and enhance old-growth forests and habitat conditions for species dependent upon old-growth within a system of well-distributed large blocks of forest (ONRC, [no date])." Also, 0.25 square miles of the LSR area has been designated as a Riparian Reserve, where the land is "managed to provide high quality water supply, habitat for salmonids, and dispersal habitat for spotted owls and other wildlife (ONRC, [no date])."

The Hoh River watershed was delineated into specific watershed characteristic zones in order to evaluate streamflow variability. The extent of these delineations are illustrated in Figure 5 below and summarized in Table 2 below. The headwater areas are dominated by highland watershed characteristics, especially in the Hoh River above the South Fork Hoh River. These areas contribute to streamflow more directly during the spring due to snowmelt. Lower elevation areas that area characterized as upland or lowland subwatersheds contribute more directly to flow during the winter, since snow melts occurs more rapidly in these areas. A more accurate description of these watershed characteristic types can be found in Appendix 1.

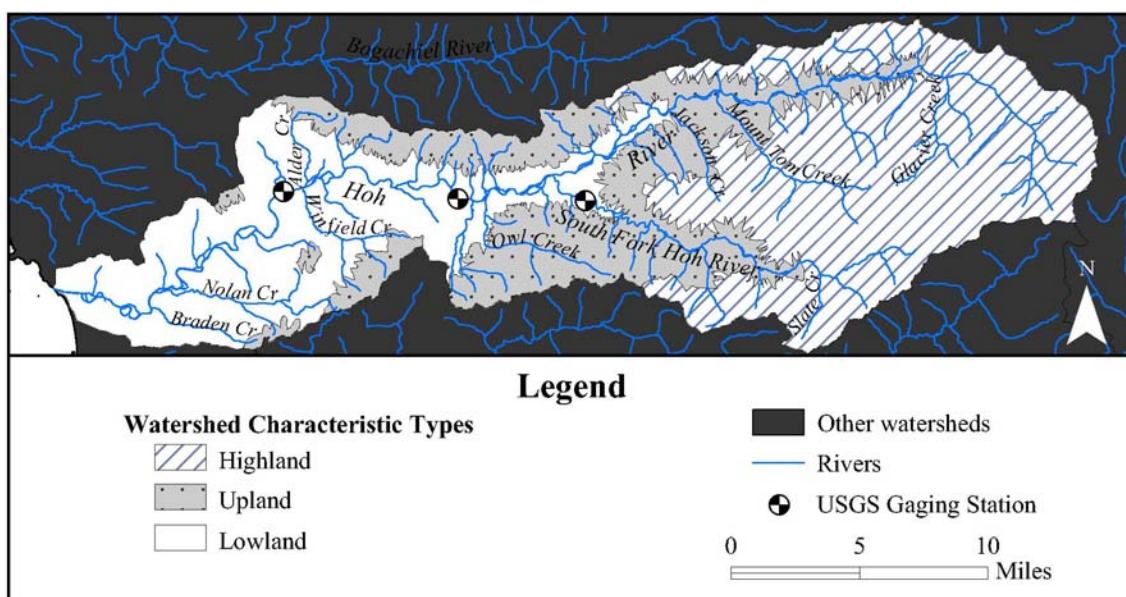


Figure 5. Watershed characteristic types within the Hoh River watershed.

Table 2. Watershed characteristics of areas within the Hoh River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Highland	124.30	41.7
Upland	78.26	26.2
Upland, <i>but ineffective</i>	3.74	1.3
Lowland	72.65	24.4
Lowland, <i>but ineffective</i>	19.22	6.4
Total Area	298.17	100

As indicated in Table 2 above, some areas of the Hoh River watershed were considered ineffective towards streamflow. Areas of large flat valleys were considered partially ineffective in regards to direct surface runoff, as some precipitation that falls on these flat areas will sink into the subsurface aquifers and not be directly measurable at the next downstream gage. Although these flows may once again become surficial further downstream, areas that function in this manner need to be identified in order to evaluate streamflow variability at ungaged locations. Additionally, these areas do not have definite boundaries, as some areas identified as “upland” or “lowland” were considered only partially effective. For example, a large portion of Hoh River ineffective areas are located in the South Fork Hoh River watershed along the flat valley bottom called “Big Flat.” This area stretches between RM 3 and RM 11. Thus, this large area is separated into relative effective and ineffective portions for inclusion in Table 2.

Streamflow Evaluations of the Hoh River

Streamflow information was compiled from three USGS gaging station records within the Hoh River watershed in order to evaluate streamflow at several locations. From upstream to downstream, these gages are:

- USGS Station Number 12040900 South Fork Hoh River near Forks, WA
- USGS Station Number 12041000 Hoh River near Forks, WA
- USGS Station Number 12041200 Hoh River at U.S. Highway 101 near Forks, WA

The most downstream gage at U.S. Highway 101 (gage 12041200) has a complete period of record during the relevant flow history from October 1961 to September 1999. Regression techniques were used to extend the other gages records based on the complete flow history recorded at Highway 101.

Streamflow was evaluated at several locations within the Hoh River watershed. These sites are indicated in Figure 6 below. Gage markers indicate locations

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where USGS gaged data was available. Ungaged locations where streamflow was evaluated are designated by a black triangle.

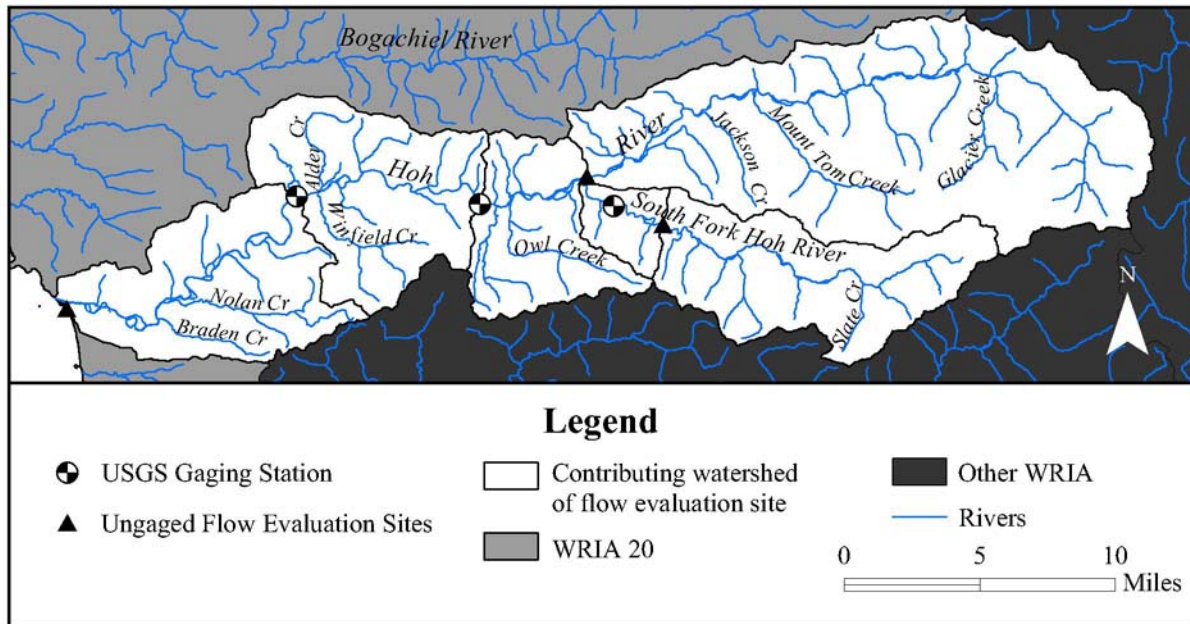


Figure 6. Flow evaluation sites and contributing watersheds within the Hoh River watershed.

Natural streamflow estimates used in this assessment were computed using the watershed characteristics method. Watershed characteristic information was required for each contributing subwatershed in order to evaluate streamflow at ungaged locations. Each subwatershed illustrated in Figure 6 is separated into watershed characteristic types in Table 3 below. To fully characterize the streamflow at a specific location, all upstream areas should be summed together. For example, the column entitled “Hoh River at Outlet” in Table 3 only describes the characteristics of the subwatersheds below Highway 101 and upstream of the outlet. This separation was necessary for developing streamflow estimates by the watershed characteristics method, but to accurately depict the entire Hoh River watershed above the outlet, all of the columns should be added together. This type of summary table for the entire watershed was presented in Table 2. The corresponding average annual precipitation numbers for each subwatershed that were used with the watershed characteristics method of gage transference are presented in Table 4.

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Table 3. Watershed characteristics within each portion of the Hoh River watershed.

Watershed Characteristic Types	South Fork Hoh River at outlet of Rainforest WAU	South Fork Hoh River at outlet	Hoh River above South Fork Hoh River	Hoh River at USGS gage # 12041000 - Hoh River nr Forks	Hoh River at USGS gage # 12041200 - Hoh River at Hwy 101	Hoh River at Outlet
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Highland	32.2	-	92.1	-	-	-
Upland	9.56	5.77	28.0	19.5	12.9	2.6
Upland- <i>ineffective</i>	3.73	-	-	-	-	-
Lowland	-	1.81	2.3	6.34	25.8	36.4
Lowland- <i>ineffective</i>	-	0.59	3.0	2.35	6.95	6.29
Entire area	45.5	8.16	125.5	28.2	45.6	45.3

Table 4. Average Annual Precipitation for each portion of the Hoh River watershed.

Watershed Characteristic Types	South Fork Hoh River at River Mile 3.6	South Fork Hoh River at outlet	Hoh River above South Fork Hoh River	Hoh River at USGS gage # 12041000 - Hoh River nr Forks	Hoh River at USGS gage # 12041200 - Hoh River at Hwy 101	Hoh River at Outlet
	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)
Highland	199.5	-	180.6	-	-	-
Upland	175.1	148.6	150.2	139.6	130.7	118.4
Upland- <i>ineffective</i>	175.1	-	-	-	-	-
Lowland	-	140.8	140.2	133.0	124.5	111.0
Lowland- <i>ineffective</i>	-	140.0	146.9	134.1	124.2	110.1
Entire area	192.4	153.5	172.3	137.6	126.2	111.3

The variability of streamflow at each of these locations is described in detail below. The provided graphs illustrate the expected variation of naturally occurring streamflow for each accumulated watershed area. The range in variation is presented in approximate average monthly flow in cubic feet per second (cfs) and is summarized in corresponding tables. These values are estimated from how frequent a monthly total flow occurred in the period between October 1960 and September 1999. Although most other WRIA 20 streamflow evaluations were only completed back to October 1961, sufficient streamflow data was available from the Hoh river gages to develop streamflow estimates back to October 1960.

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South Fork Hoh River at River Mile 3.6 (the outlet of Rainforest WAU) –

Streamflow in the South Fork Hoh River was measured at USGS gage # 12040900 for 5 years between July 1985 and October 1989. These data were collected at RM 1.5 and were extended using regression techniques against the USGS gage on the Hoh River at Highway 101. Streamflow at RM 3.6 was estimated using the watershed characteristics method and the period of record extended between October 1960 and September 1999 (water years 1961 to 1999). This estimated streamflow record is presented in Appendix 3.

Streamflow in the South Fork Hoh River shows a bi-modal distribution, with monthly average streamflow peaking typically in the month of November and again in June due to snowmelt runoff. During the late summer and early fall, flow in the South Fork Hoh River recedes to minimum or base flow. This minimum flow season extends into September. The months between November and February exhibit the greatest indicated variation in streamflow.

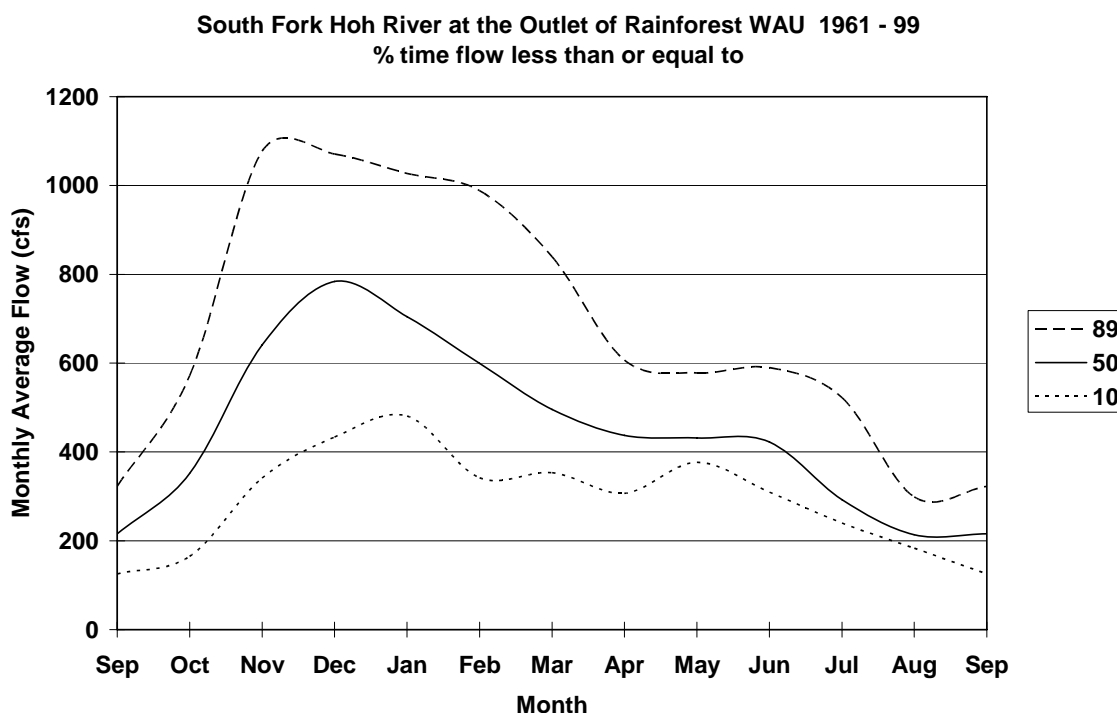


Table 5. Percent of time that average monthly streamflow (cfs) would be less than or equal to the value for each month in the South Fork Hoh River at RM 3.6.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	571	1077	1071	1027	988	839	607	578	590	522	299	323
50	352	641	784	705	600	496	437	431	423	293	214	216
10	165	341	433	481	342	354	307	377	309	240	183	125

South Fork Hoh River at the Outlet –

The gaged streamflow data collected by the USGS on the South Fork Hoh River was again used to evaluate streamflow at the outlet through the watershed characteristics method. This estimated streamflow record was generated between October 1960 and September 1999 and is included in Appendix 3.

Streamflow at the outlet of the South Fork Hoh River exhibits similar characteristics to the flow described at RM 3.6. The primary differences between these sites are an increase in overall flow, even at low flow times, and greater variability in the winter months. This additional variability is expected, since the additional 8.2 square-miles area contributing to streamflow between RM 3.6 and the outlet are characterized as upland and lowland subwatershed areas, where the snowpack is not sustained for a long period of time.

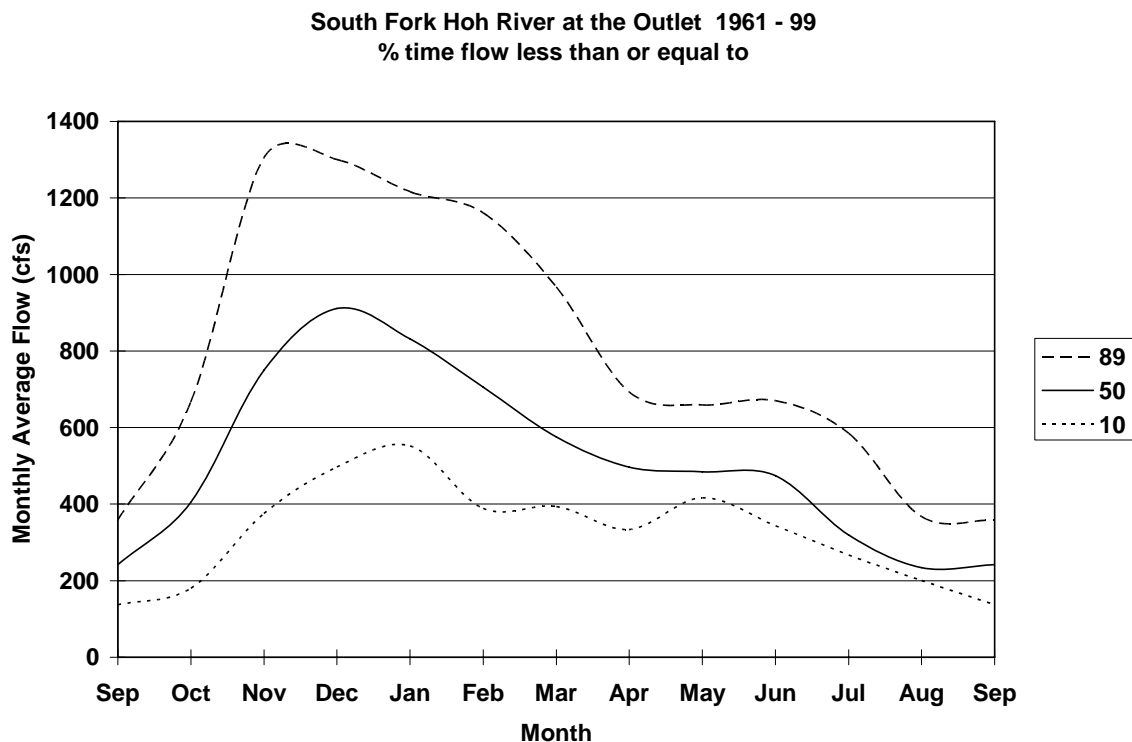


Table 6. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the outlet of the South Fork Hoh River.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	667	1305	1300	1216	1161	967	693	659	670	585	367	358
50	406	750	911	832	706	575	497	485	474	319	234	242
10	180	376	496	552	388	394	334	417	343	267	200	137

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Hoh River above the South Fork Hoh River confluence –

Streamflow of the Hoh River above the South Fork confluence was generated using the watershed characteristics method. The extended flow history for USGS gaging station number 12041000, Hoh River near Forks, accounted for the flow in both the South Fork and mainstem branches of the Hoh River. The Hoh River above the South Fork confluence was generated by subtracting out all other water contributing to this gage. Thus, streamflow generated by the mainstem Hoh River between the South Fork confluence and the gage was estimated using the watershed characteristics method and subtracted from the Hoh River gage number 12041000, along with streamflow estimated at the outlet of the South Fork Hoh River. This estimated record was also generated between October 1960 and September 1999 and can be found in Appendix 3. The months between November and February exhibit the greatest indicated variation in streamflow. During the late summer and into the fall, flow in the Hoh River recedes to minimum flow. This minimum flow season is indicated to extend into September.

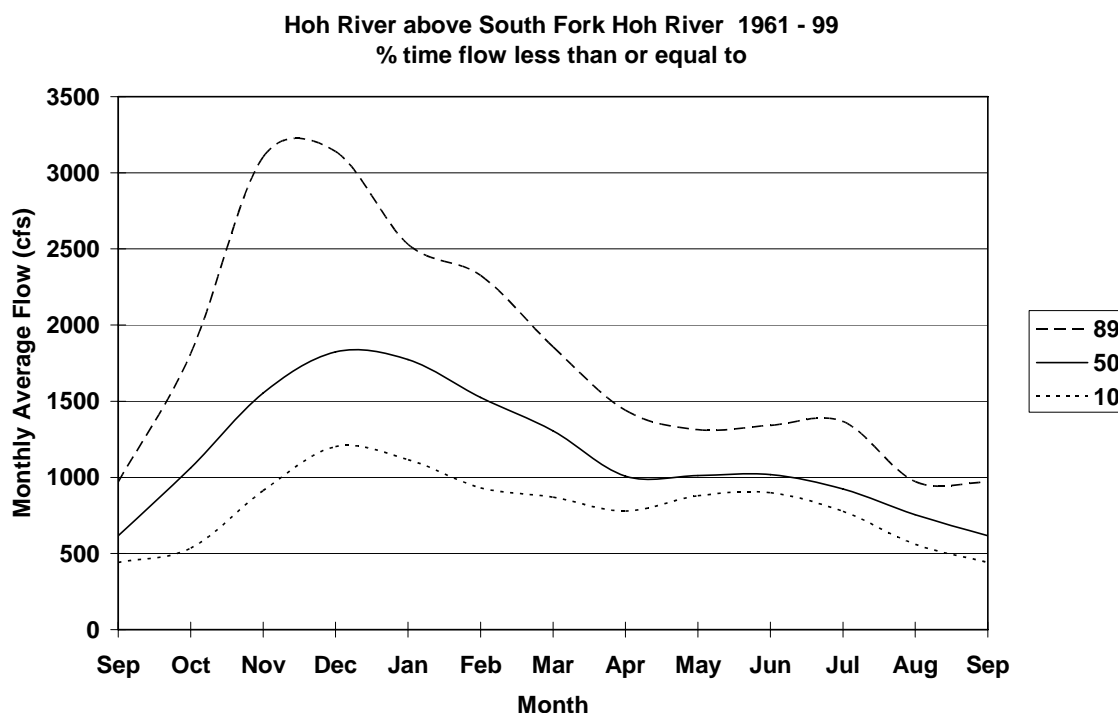


Table 7. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River above the outlet of the South Fork Hoh River.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1812	3105	3140	2530	2326	1858	1440	1313	1342	1366	972	969
50	1063	1555	1824	1775	1525	1305	1008	1012	1019	924	755	616
10	535	913	1202	1116	932	870	778	878	899	775	560	441

Hoh River near Forks (at USGS Gage 12041000) –

Streamflow information was collected at RM 25.6 of the Hoh River by the USGS between August 1926 and September 1964. This gaged streamflow record was extended using regression techniques against the streamflow record from USGS gage 12041200, Hoh River at Highway 101. Several regression equations were used to estimate streamflow more accurately at high, medium, or low flow periods. This estimated record was also generated between October 1960 and September 1999 and can be found in Appendix 3.

Streamflow in the Hoh River is characterized by a bi-modal distribution, with monthly average streamflow peaking typically in the late fall or winter and again in the spring due to snowmelt runoff. The months between November and February exhibit the greatest indicated variation in streamflow. Streamflow in the Hoh River recedes to minimum flow during the late summer and into the fall. This minimum flow season is indicated to extend into September.

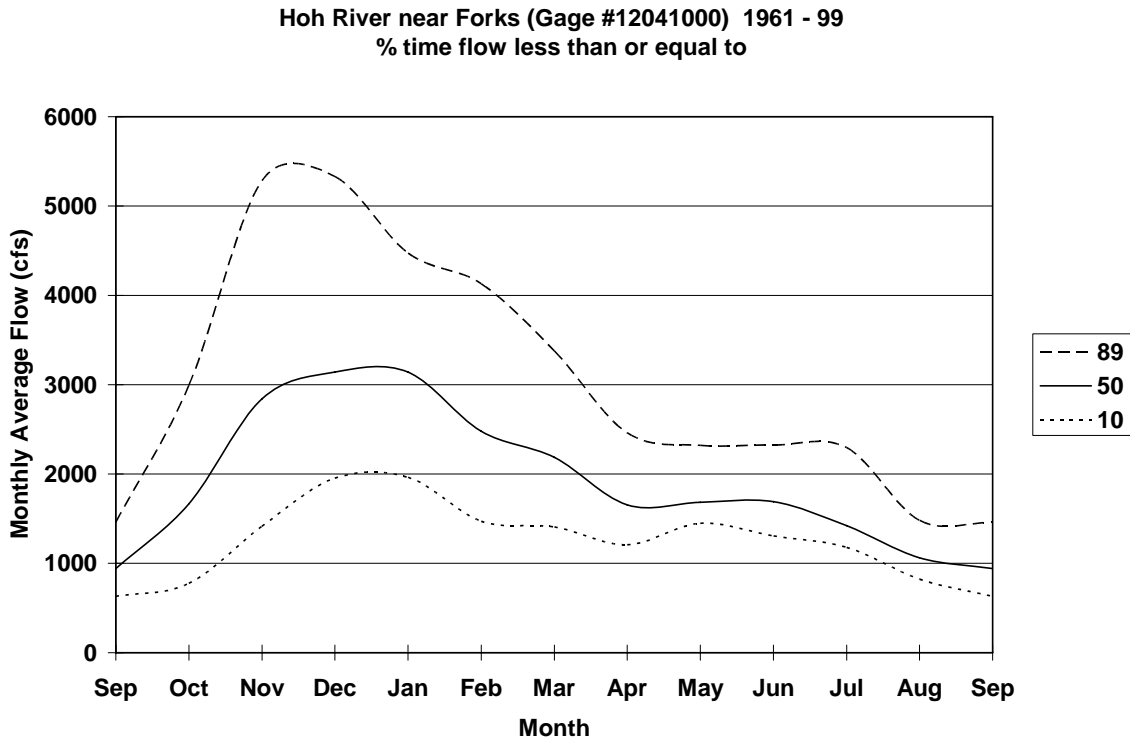


Table 8. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River near Forks.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	2990	5282	5329	4473	4130	3379	2460	2320	2324	2296	1480	1458
50	1668	2840	3139	3140	2479	2186	1654	1684	1691	1420	1063	940
10	773	1415	1954	1961	1471	1407	1209	1448	1306	1179	822	631

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Hoh River at U.S. Highway 101 (at USGS Gage 12041200) –

As stated previously, a complete period of record was available for the Hoh River at the Highway 101 bridge. The USGS gaging station at this location began operation in October 1960 and is still in operation today. The data used to evaluate streamflow variability at this location were derived from these gaged data. The streamflow evaluation was limited to data recorded between October 1960 and September 1999, which can be found in Appendix 3.

Streamflow in the Hoh River at the Highway 101 bridge illustrates highly similar characteristics to the USGS gaged location at RM 25.6. The only changes exhibited at this location were an increase in streamflow totals and greater variability, especially in the winter. Again, the months between November and February exhibit the greatest indicated variation in streamflow. Hoh River streamflow recedes to minimum flow during the late summer and into the fall. This minimum flow season is observed to extend into September.

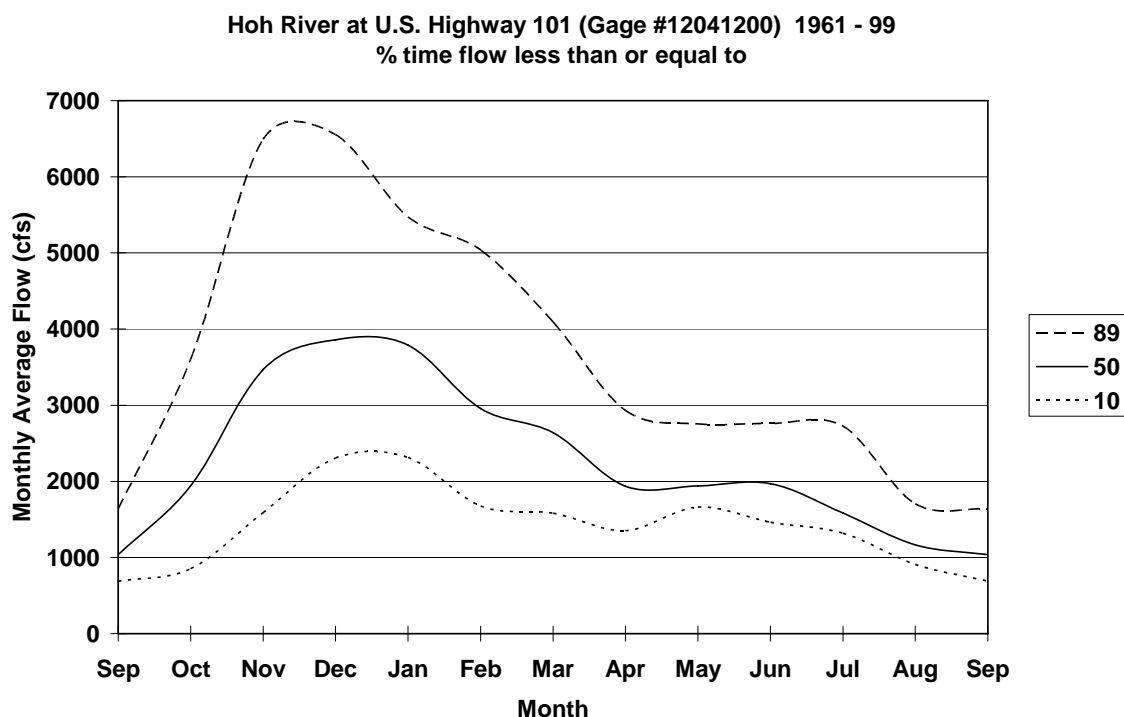


Table 9. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River at U.S. Hwy 101.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	3601	6493	6553	5472	5039	4092	2932	2755	2761	2725	1703	1639
50	1942	3470	3860	3790	2957	2641	1935	1940	1970	1585	1167	1038
10	852	1589	2304	2314	1675	1580	1352	1662	1464	1318	907	688

Hoh River at the Outlet –

Streamflow of the Hoh River at the outlet into the Pacific Ocean was estimated using the watershed characteristics method. Since a complete period of record was available at the USGS gage 12041200, Hoh River at U.S. Highway 101, only the additional streamflow below Highway 101 needed to be estimated using the differences between the Highway 101 and the Forks gage (USGS gage 12041000). The streamflow gains between those two gages were rescaled based on the watershed characteristics method to estimate the streamflow generated by remaining contributing area below Highway 101 and added to recorded streamflow at Highway 101 to represent expected monthly total streamflow at the outlet into the Pacific Ocean. Unlike other WRIA 20 rivers, incidental streamflow measurements of the Hoh River at or near the outlet were not available for use in calibrating these estimates. The only changes exhibited at this location from the Highway 101 location are an increase in streamflow totals and greater variability, especially in the winter months when the intermediary lands contribute directly to streamflow.

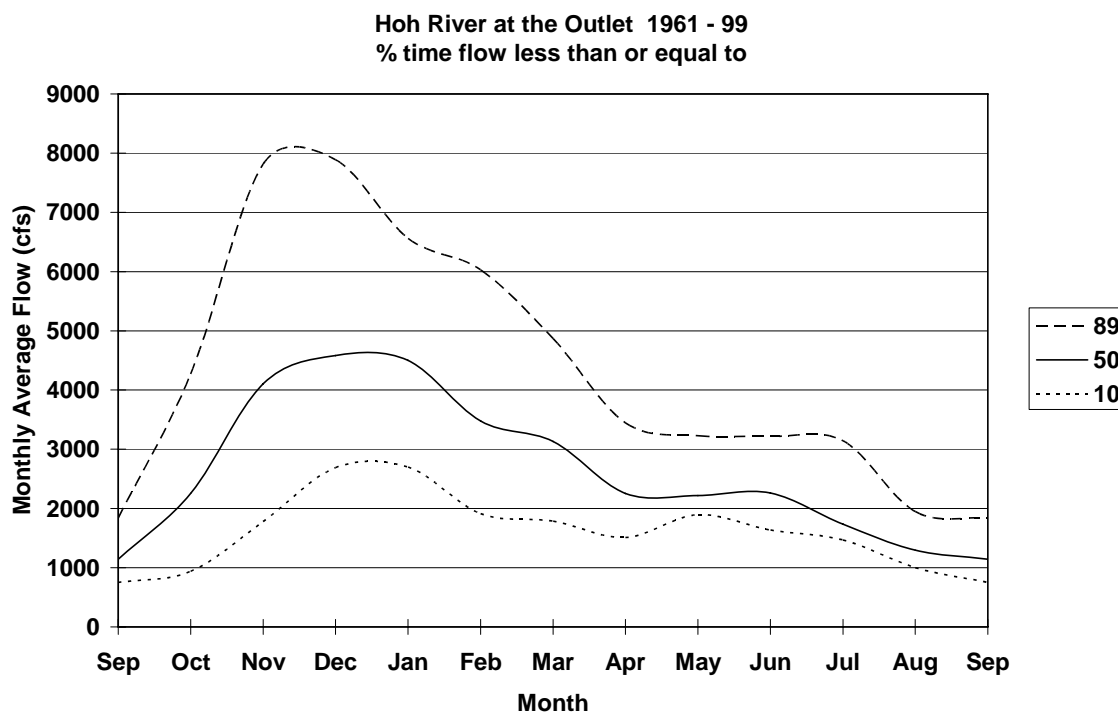


Table 10. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River at the outlet.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	4268	7813	7886	6561	6030	4869	3447	3230	3220	3141	1947	1836
50	2257	4107	4584	4499	3477	3133	2254	2219	2260	1732	1295	1146
10	937	1779	2687	2698	1911	1784	1509	1896	1636	1469	1001	750